System Modifications Enhance Nitrogen Reduction in Advanced Onsite Wastewater Treatment Systems

A study sponsored by the U.S. Environmental Protection Agency's Chesapeake Bay Program evaluated appropriate technologies to achieve an end-of-pipe performance standard equal to or less than 14.0 mg/L total nitrogen (average). This standard supports the 1987 Chesapeake Bay Agreement strategy to reduce nitrogen entering the Bay by 40% by the year 2000.

The Problem

Excess nitrogen (N) entering the Chesapeake Bay can create significant water quality problems and is causing millions of dollars of damage and lost revenue annually. Nitrogen pollution can also degrade groundwater, and can contribute to adverse health effects in drinking water. While nitrogen pollution may come from many sources, individual septic systems can be a significant contributor.

In 2009 the state of Maryland established a requirement that all new onsite wastewater treatment systems in critical areas employ approved "best available technologies (BAT)." These BAT treatment systems must be approved by the Maryland Department of the Environment and are required to reduce nitrogen by at least 50%.

Nitrogen Reducing Technologies

The most common way to remove nitrogen from wastewater is by the microbiological processes of nitrification and denitrification. Nitrification is an aerobic process that results in nitrogen in the form of nitrates. Nitrates can then be converted to nitrogen gas and removed from the wastewater by denitrification, which requires a zone almost devoid of dissolved oxygen and which has a source of organic carbon.

Proprietary technologies exist that are capable of reducing nitrogen but they can be expensive and are not available in all areas of the country. The nitrogen reducing systems examined in this study were not proprietary. They used multi-compartment septic tanks, plastic media, blowers and air lift pumps to create the zones for biologic nitrogen reduction. The monitoring program deployed in this study determined that over a year's time these engineered systems reduced end-of-pipe nitrogen by 68%.

Homes in the Chesapeake Bay area are often located in close proximity to the water making wastewater disposal difficult.

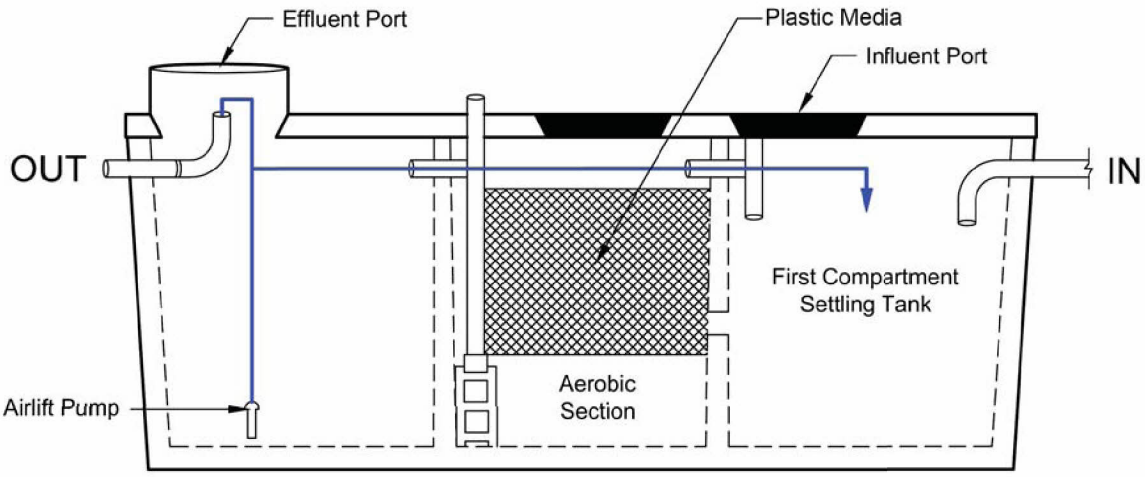
Background

For one year, three residential onsite wastewater treatment systems, modified with nitrogen reducing technologies, were monitored for their effectiveness in reducing nitrogen. The systems consisted of replacing single compartment septic tanks with multi (2 or 3) compartment septic tanks of either fiberglass or concrete.

The first compartments were anaerobic zones for denitrification, using wastewater as the organic carbon source. Plastic media added to the following aerobic compartments provided surface area for the growth of nitrifying bacteria to enhance their production of nitrates. Some of the wastewater, now containing nitrates, was circulated back to the first compartments where nitrates are converted to nitrogen gas, reducing levels of nitrogen in the systems. The treated wastewater was then discharged into drainfields.

Objective

The primary objective of this study was to evaluate onsite wastewater treatment systems to determine if they could reduce average total nitrogen levels to 14.0 mg/L or less.



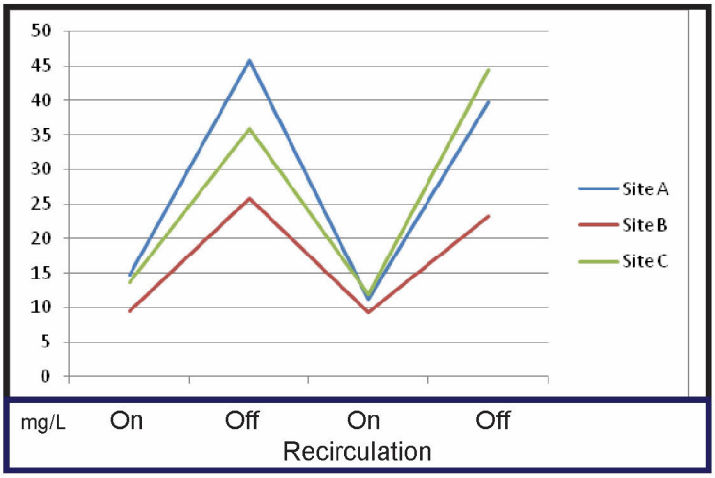
Engineered Wastewater Treatment System Configuration

Methods

• 24-hour composite samples were collected weekly for one year.
• Samples were collected and analyzed by an EPA-certified laboratory for NO_3/NO_2 and TKN.
• To determine influent total nitrogen levels, recirculation, and thus nitrogen reduction, was purposely eliminated for periods of time.

Results

• With recirculation on, nitrogen levels were low and with recirculation off, nitrogen levels were high.
• When the systems were operating as designed they all achieved less than 14.0 mg/L average total nitrogen in the effluent for an overall reduction of 68%.
• With a 68% reduction, 14.0 mg/L can be achieved when influent total nitrogen levels average less than 45 mg/L.



Total average nitrogen with recirculation on versus off.

Operation and Maintenance

• These systems use a blower that runs continuously and requires 86 Watts of electricity to operate.
• The system's tank should be pumped every 3 years for residences with 2-4 occupants.
• Systems should be inspected and serviced twice a year to ensure proper operation.

Conclusions

• Engineered systems using separate compartments for nitrification and denitrification can significantly reduce nitrogen from onsite wastewater treatment systems.
• When the systems were operating properly, they consistently and reliably reduced nitrogen levels by an average of 68%.
• Although the systems monitored in this project reduced nitrogen levels to the goal of 14.0 mg/L or less, those levels may not be achievable with more concentrated wastewater.
• Periodic maintenance is necessary to ensure systems are operating properly.

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